Claims

1. A method of communication using Orthogonal Frequency Division Multiplexing ('OFDM') from a transmitter comprising a plurality of transmit antenna means and a receiver comprising at least one receive antenna means, the method comprising generating bit streams and corresponding sets of N frequency domain carrier amplitudes ($\tilde{s}(kN+j),\ 0 \le j \le N-1$) modulated as OFDM symbols subsequently to be transmitted from a transmitter, where k is the OFDM symbol number and j indicates the corresponding OFDM carrier number, inserting affix information into guard intervals between consecutive time domain OFDM symbols, transmitting said time domain OFDM symbols including said affix information from said transmitter to said receiver, using said affix information at the receiver to estimate the Channel Impulse Responses ($\mathbf{H}_{lm}$ between the lth transmit and mth receive antenna) of the transmission channels between said transmitter and said receiver, and using the estimated Channel Impulse Response ($\hat{\mathbf{H}}_{lm}$ between the lth transmit and mth receive antenna) to demodulate said bit streams in the signals received at said receiver,

   characterised in that said affix information is known to said receiver as well as to said transmitter, and is mathematically equivalent to a vector ($\mathbf{c}_D$) that is common to said time domain OFDM symbols multiplied by at least first weighting factors (α_k) that are different for one time domain OFDM symbol (k) than for another and second weighting factors ($w_i(k)$) that enable one of said transmit antenna means (i) to be distinguished from another.

2. A method of communication as claimed in claim 1, wherein said first weighting factors (α_k) have pseudo-random values.

3. A method of communication as claimed in claim 1 or 2, wherein said first weighting factors (α_k) have complex values.

4. A method of communication as claimed in any preceding claim, wherein said first weighting factors (α_k) are deterministic and are known to said receiver as

well as to said transmitter independently of current communication between said receiver and said transmitter.

5. A method of communication as claimed in any of claims 1 to 3, wherein said first weighting factors (a_k) are communicated from said transmitter to said receiver.

6. A method of communication as claimed in any preceding claim1, wherein said transmitter uses N_t transmit antenna means and the receiver uses N_r receive antenna means, M' consecutive time domain OFDM data symbols are encoded by a specific space-time encoder $\mathcal{M}$ such that the encoder $\mathcal{M}$ produces M time domain OFDM data signals outputs for each of the N_t transmit antenna means, and said vector ($\mathbf{c}_D$) is encoded by a specific space-time encoder $\mathcal{W}$ such that the encoder $\mathcal{W}$ produces M affixes for each of the N_t transmit antenna means corresponding to said affix information weighted by said first and second weighting factors (a_k) and $w_i(k)$, the resulting affixes being inserted between time domain OFDM data symbols for each of the N_t transmit antenna means.

7. A method of communication as claimed in claim 6, wherein all transmit antenna outputs over M consecutive OFDM time domain symbols, including time domain OFDM data symbols space-time encoded by $\mathcal{M}$ and pseudo-random affixes space-time encoded by $\mathcal{W}$, are grouped into a ***block S***, for which said first weighting factors (a_k) are the same for OFDM symbols of the same ***block S*** but are different for OFDM symbols of different ***block S***.

8. A method of communication as claimed in claim 7, wherein said transmitted affixes enable the separation at said receiver of the transmitted guard interval affix information of said ***block S***, and said second weighting factors ($w_i(k)$) enable the separation and estimation at said receiver of the different physical channels between said transmit antenna means and said at least one receive antenna means.

9. A method of communication as claimed in any preceding claim, wherein the matrix $\mathbf{W}$ corresponding to $M \times N_t$ of said second weighting factors ($w_i(k)$) for a number M of consecutive symbols and for said N_t transmit antenna means is an orthogonal matrix such that when multiplied by its complex conjugate transpose $\left((\mathbf{W})^T\right)^*$ the result is the identity matrix ($\mathbf{I}$), weighted by a gain factor g_0 having a non-zero real value (i.e. $g_0\mathbf{I} = \mathbf{W}^H\mathbf{W}$).

10. A method of communication as claimed in claim 9, wherein demodulating said bit streams includes, for each said receive antenna means, multiplying a signal derived from the received signal $\mathbf{d}_m$ by the complex conjugate transpose of the Kronecker product of said matrix of said second weighting factors ($w_i(k)$) for said transmit antenna means by the identity matrix ($(\mathbf{W} \times \mathbf{I}_D)^H$) and using channel estimates derived form the results in demodulating said bit streams.

11. A method of communication as claimed in any of claims 6 to 8, wherein the matrix of said second weighting factors ($w_i(k)$) for said transmit antenna means and for a number N_T of consecutive symbols equal to the number N_T of said transmit antenna means is a non-orthogonal matrix ($\mathbf{W}$) such that when multiplied by its complex conjugate transpose $\left((\mathbf{W})^T\right)^*$ the result is different from the identity matrix ($\mathbf{I}$), weighted by a gain factor g_0 having a non-zero real value (i.e. $g_0\mathbf{I} \neq \mathbf{W}^H\mathbf{W}$).

12. A method of communication as claimed in claim 10, wherein the matrix of said second weighting factors ($w_i(k)$) for said transmit antenna means and for a number N_t of consecutive symbols equal to the number N_t of said transmit antenna means is a matrix ($\mathbf{W}$) such that ($\mathbf{W}$) alone is non-orthogonal, but ($\mathbf{W}$) combined with the corresponding pseudo-random factors (a_k) is orthogonal.

13. A method of communication as claimed in any preceding claim, wherein said second weighting factors ($w_i(k)$) take different values for each of said transmit antenna means so as to enable said physical channels to be distinguished.

14. A method of communication as claimed in any preceding claim, wherein estimating the Channel Impulse Response ($\mathbf{H}_{lm}$) of the transmission channels between said transmitter and said receiver comprises a step of making a moving average estimation over a plurality of symbol periods of channels which are mathematically equivalent to the relationship:

$$\mathbf{h}_{lm}^{D}(n)=\sum_{k=0}^{n}J_0(2\pi f_D k\Delta T)\tilde{\mathbf{h}}_{lm}^{D}(n-k)$$

where $J_0(\cdot)$ is the 0th order Bessel function, f_D is the Doppler frequency, ΔT is the MTMR PRP-OFDM block duration and $\tilde{\mathbf{h}}_{lm}^{D}(n)$ is zero-mean complex Gaussian of constant variance.

15. A transmitter for use in a method of communication as claimed in any preceding claim and comprising generating means for generating said bit streams modulated as OFDM symbols to be transmitted and for inserting said affix information into said guard intervals between said OFDM symbols, said guard interval affix information being deterministic and suitable to be known to said receiver as well as to said transmitter and including said vector ($\mathbf{c}_D$) that is common to said time domain OFDM symbols multiplied by said first weighting factors (a_k) that are different for one time domain OFDM symbol (k) than for another and said second weighting factors ($w_i(k)$) that enable one of said transmit antenna means (i) to be distinguished from another.

16. A receiver for use in a method of communication as claimed in any of claims 1 to 13 and comprising demodulating means for receiving signals that comprise said bit streams modulated as said OFDM symbols with said guard interval affix information inserted between said OFDM symbols, said demodulating means being arranged to use said affix information from said guard intervals to estimate the Channel Impulse Response of the transmission channels and to use the estimated Channel Impulse Response to demodulate said bit streams in the signals received at said receiver, said guard interval affix information ($w_i(k)a_k.c_0$ to $w_i(k)a_k.c_{D-1}$) being deterministic and being known to said receiver.